Physical Instrument Models

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Definition & Concepts (1)

- S/W to simulate realistically the data produced by observations
- based on physical principles (eg. interference & diffraction on gratings)
- signal path strictly followed (ie. convolutions remain convolutions)
- level of complexity defined by needs of application (eg. time dependency, polarization)
- predictive power (physical principles), quantifiable (engineering parameters)

Definition & concepts (2)

- `fudge' factors allowed only if
  - sufficient to keep realism, but increasing speed (fudge derived from full model)
    - » or if
  - no physical prescription available yet (eg. funny detectors)
- Note: The latter condition usually is the source of known deficiencies in `classical' calibration (eg. non-understood CTE problems)

Goals & applications

- Predictive power to describe certain characteristics of raw data (eg. scattered light)
- 3 Levels of application in calibration and analysis
  - post-pipeline `correction' tool (eg. predict effect on final product)
  - generate smooth calibartion reference data
  - predict raw data for a variety of possible model targets, compare with raw observations
- During instrument design and laboratory testing
  - evaluate calibration and data analysis S/W requirements
  - drive instrument design (eg. recommend action against red leaks)
  - provide a reference to evaluate lab test data

ST-ECF / DMD joint project (1)

- Status:
  - FOS: complete model (flux aspect, geometrical aspect, orbital background) (1994 – 1997) used now to prepare corrective procedures for FOS Final Archive (1.5 FTE over 3 years)
- Generic spectrographs:
  - 2D geometric — published April 1997 Ballester (DMD) & Rosa (ST-ECF)
  - C++ library of optical components, toolbox, user interface, database I/O
  - Non-ideal gratings, LSF and efficiency (started October 1997)
  - Quantum mechanical description developed, will employ Monte-Carlo methods

ST-ECF / DMD joint project (2)

- Applications:
  - 2D generic geometry works for: CASPEC (LaSilla), UVES (VLT), STIS, GHRS (HST), IUE
  - FOS dispersion model works for: EFOSC, EMMI
  - Porting of concepts and modules in progress for ISO

ST-ECF project — mid-term plan (1)

- 1998
  - finish geometric description of all STIS modes, use to
    - » cover uncalibrated modes
    - » support 2D spectral extraction / flux calibration S/W development
    - » first fix for scattered light effects in echelle modes (positional dependencies)
  - develop, test non-ideal grating code; use to
    - » definitively cope with scattered light effects in echelle modes (LSF, Lambda dependencies)
  - implement non-linear optimization codes (eg. simulated annealing)
    - » required to tune model setup parameters for many modes
    - » required to bind models as modules in the data flow / quality testing
    - » requires additional (outside) experties (C++, numerics)

ST-ECF project — mid-term plan (2)

- apply model-based results during the production of FOS Final Archive
  - » provides feed back for concept and S/W
- 1999
  - use suite of tools to explore the forward data analysis concept
    - » i.e. simulate raw data from an array of possible targets (SEDs) trial-and-error optimize target characteristics to a statistical match of observed data (eg. simulated annealing)